Solar - lunar tides in Earth crust on the data of monitoring of a level of underground waters in Chu basin of Kyrgyzstan.

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With the purpose of research of regularity of a mode of levels and changing of resources of fresh underground waters of Quaternary water-bearing complex in the territory of Chu valley of Kyrgyzstan, in May, 2012 the automatic monitoring of a level of underground water of Quaternary water-bearing complex of Ala-Archa deposit of underground waters was begun. It is monitoring with the help of the gauge" «OTT_ecoLog_500", (http://www.hachhydromet.com/web/ott_hach.nsf/id/pa_ground_water_level_sensors.html), given for scientific researches by firm «OTT Hydromet GmbH», (Kempten, Germany). The sensor «OTT_ecoLog_500» is established in a well № 1301-4, of observation network of regime wells of Kyrgyz complex hydrogeological expedition of agency on geology and mineral resources KR. This well is located on western outskirts of Bishkek (42°52'1.06"N - 74°28'50.31"E in WGS 84), the absolute mark of surface of the ground 739 m). Its site is shown in figure 1 and under the reference: (http://maps.google.com/maps/ms?ie= UTF&msa=0&msid=203965682782791499971.0004b53779c0491758c3a).

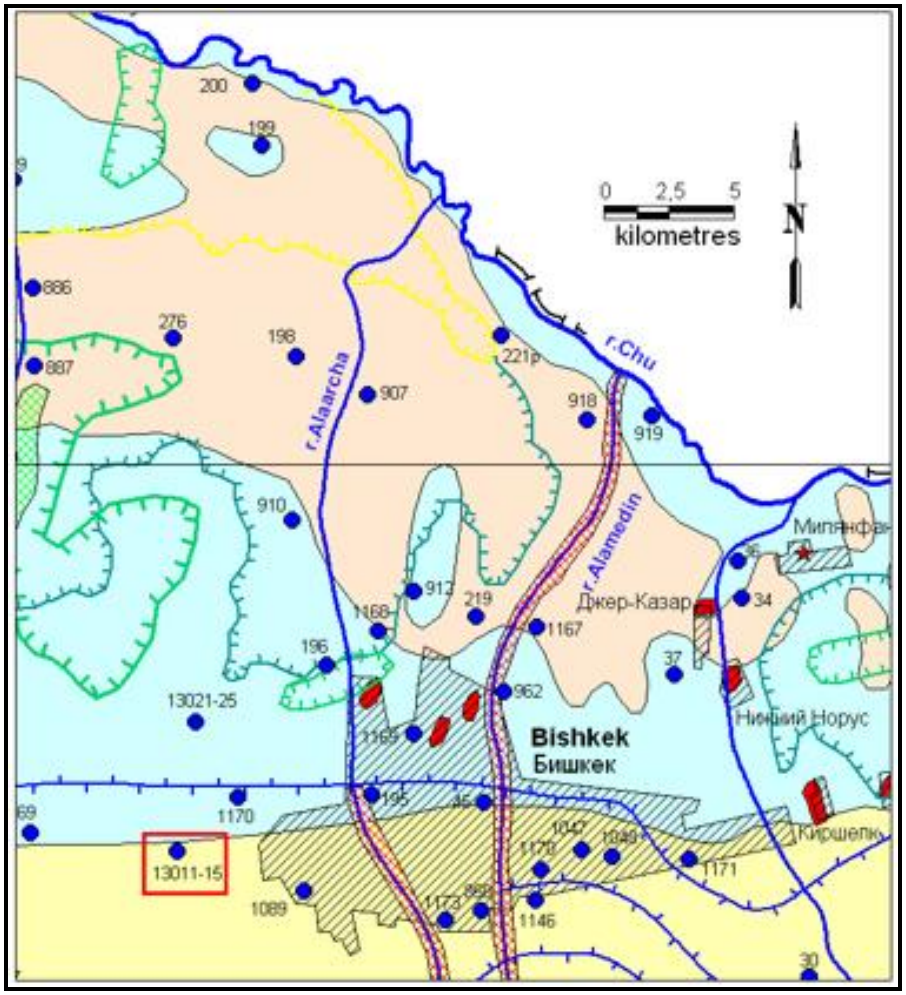

Fig. 1 Scheme of an arrangement of regime wells in Chu valley
(Red rectangular shows a position of a well 1301-4)

in the same well the previous years, as shown in figure 4, and as in other wells of Chu basin, as it is shown in figure 5.

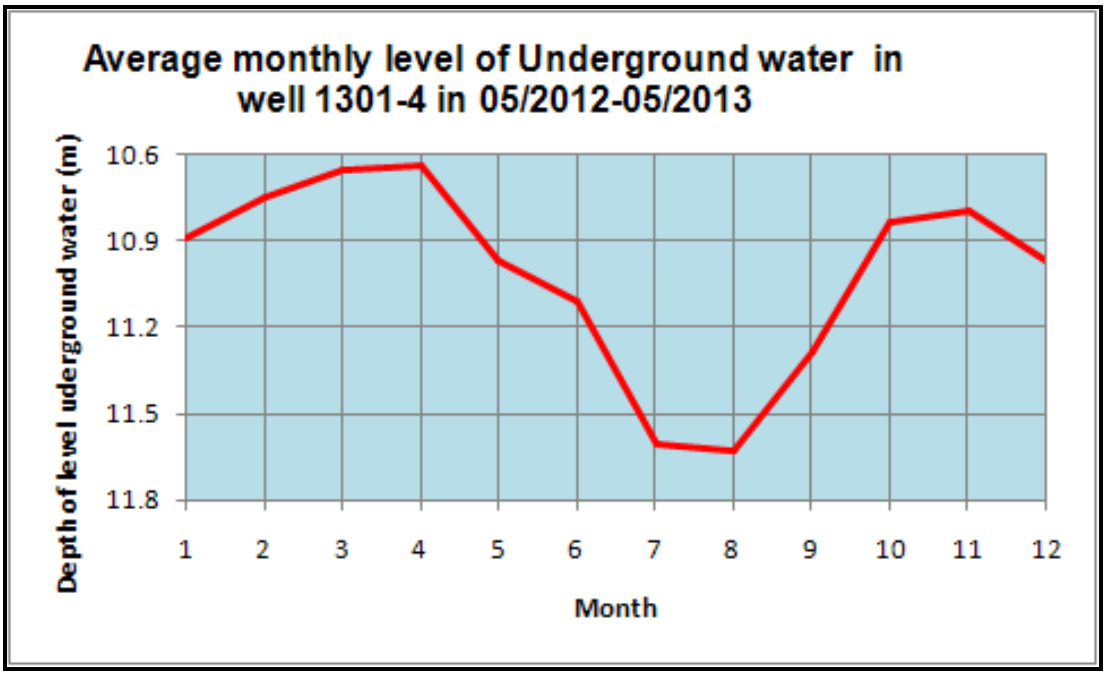

Fig. 3

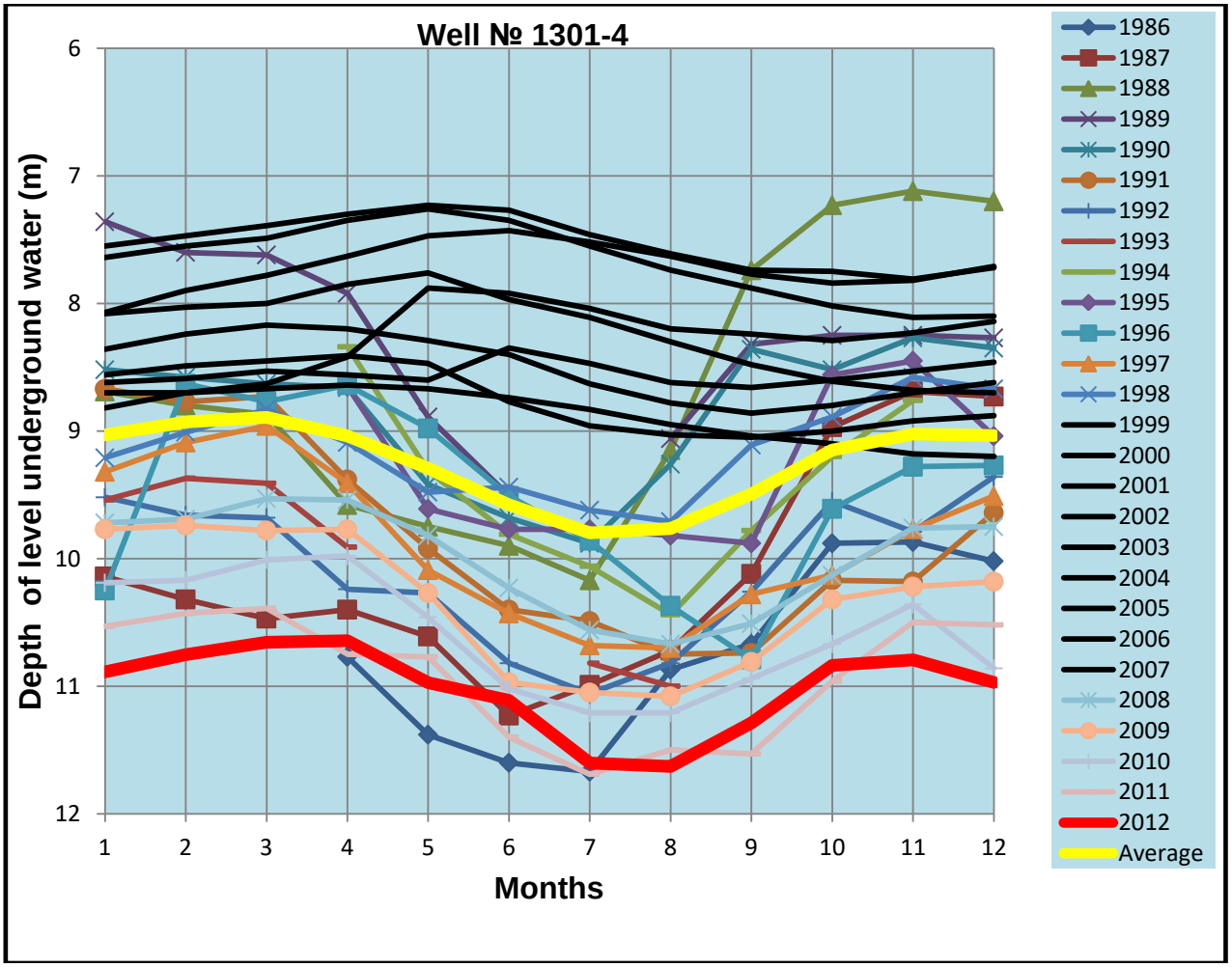

Fig. 4

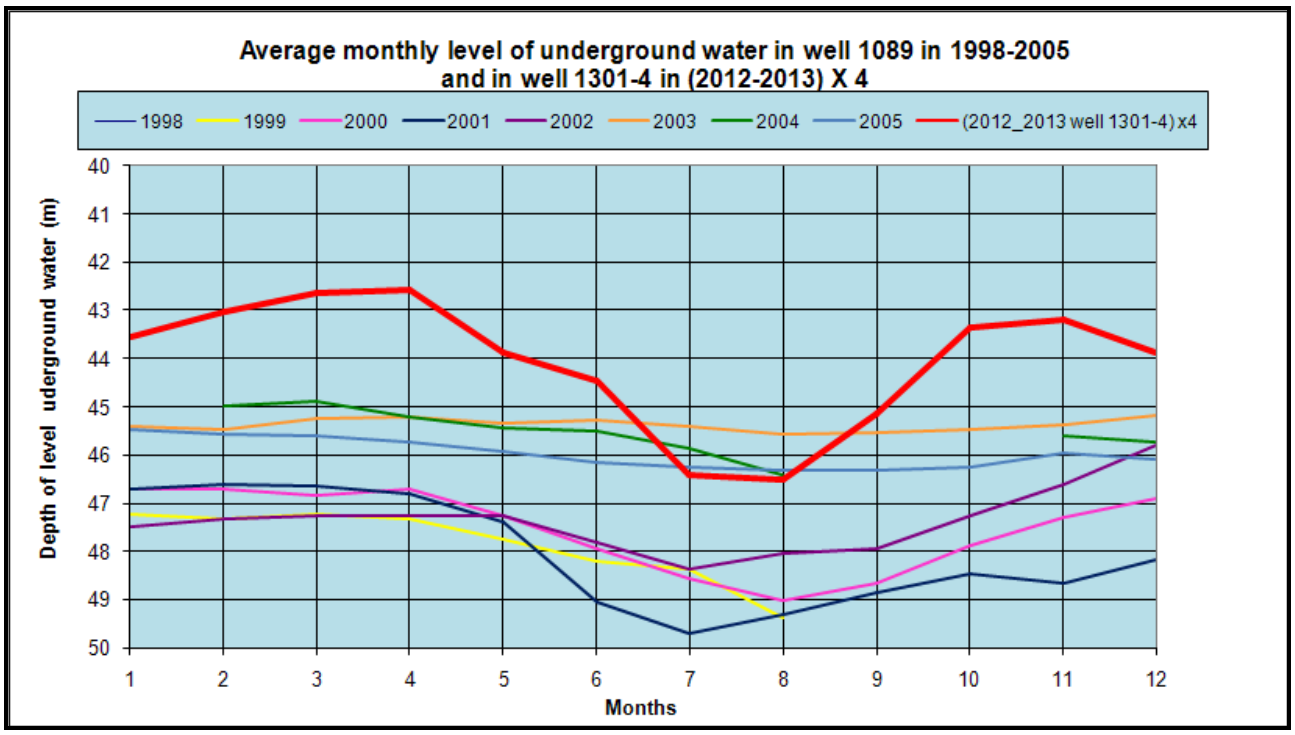

Fig. 5

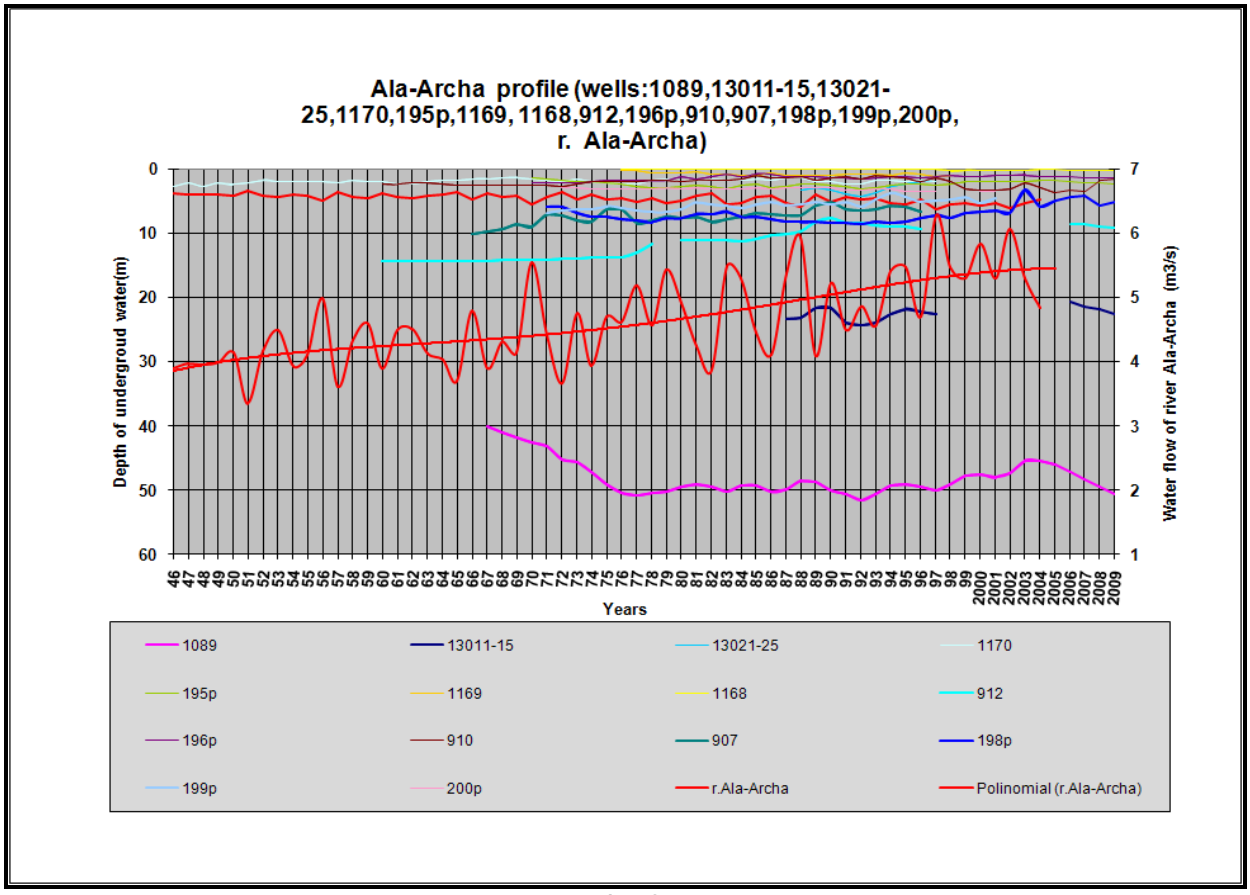

Fig. 6

In figure 6 as shown, on the data KCHGE and Kyrgyzhydromet, the average annual course of levels of underground waters since 1946 for 2009 on a observant wells, including well 1301-4. And as change of the average long-term water flow of the river Ala-Archa, which gives a significant part of feed of these underground waters. As shown in this diagram, it is observed the long-term tendency of increase of the flow of water in the river.

At the same time, level of underground waters tends both increase and decrease on separate wells, without the obvious general tendency to increase. As a whole, it corresponds fixed earlier during study of a mode of underground waters non-uniform on duration to the periods of fluctuations of the level, about several years, and as several tens years, characteristic for all underground waters of zone active water cycle of basin. Thus, within the limits of territory, is adjacent to a considered of wells, there is no unequivocal long-term change of static stocks of underground waters of Ala-Archa deposit of underground waters.

In figure 4 is shown a level of underground waters on a well 1301-4 for the period from 1986 to 2012. Here, certain grouping of levels on depth, characteristic for the period of time with 1999 for 2007, allocated with black colour pays itself attention on. They differ by a rather smaller depth and smaller contrast of maxima and minima, in comparison with levels other years. This feature reflects long-term variability in location of a level of underground waters depending on change of climatic conditions and accordingly of feed) of underground waters. Now, the level is close to maximal, for the period of supervision to depth , similar to depths during 1986 -1987, but, as a whole, does not leave for a range of depths having a place in the past, at long-term amplitude of a level about 4 m. That is, on this well in 2012-13 the marked above absence of the definite tendency of change of stocks of underground waters of Ala-Archa deposit.

In contrast to considered above, concerning the long periods of fluctuations of a level of underground waters determined by seasonal and climatic changes of size of a feed of underground waters, the short periods of fluctuations of a level in a well 1301-4 are connected with tidal movements of terrestrial crust and depend on position of the Moon and Sun concerning the Earth. Most brightly the tidal fluctuations are shown during day as two maxima and minima of a level of underground waters, as shown in figure . This implies, what, in the diagram of a level of underground waters to the maximal depths or minima of a level correspond of rising in terrestrial crust, and to the minimal depths or maxima of a level correspond of lowering in terrestrial crust, both its appropriate stretching and compression [1].

The period between two daily minima of a level about 12 hours, that corresponds to half of lunar day (12 ч. 25 mines.). The period between two daily maxima is about 6 hours. As a rule, the first daily minimum and maximum have the large amplitudes, than seconds, which correspond weaker of second tide wave.

Generally, the maximal amplitude of a level of underground waters is about 0,75 м, and minimal is about 0,3-0,4 m. Besides, the fluctuations of a level with one maximum and minimum within day are observed , or with the poorly expressed second minimum and maximum, that gives asymmetric character to peaks of the diagram, that is shown in figure 8.

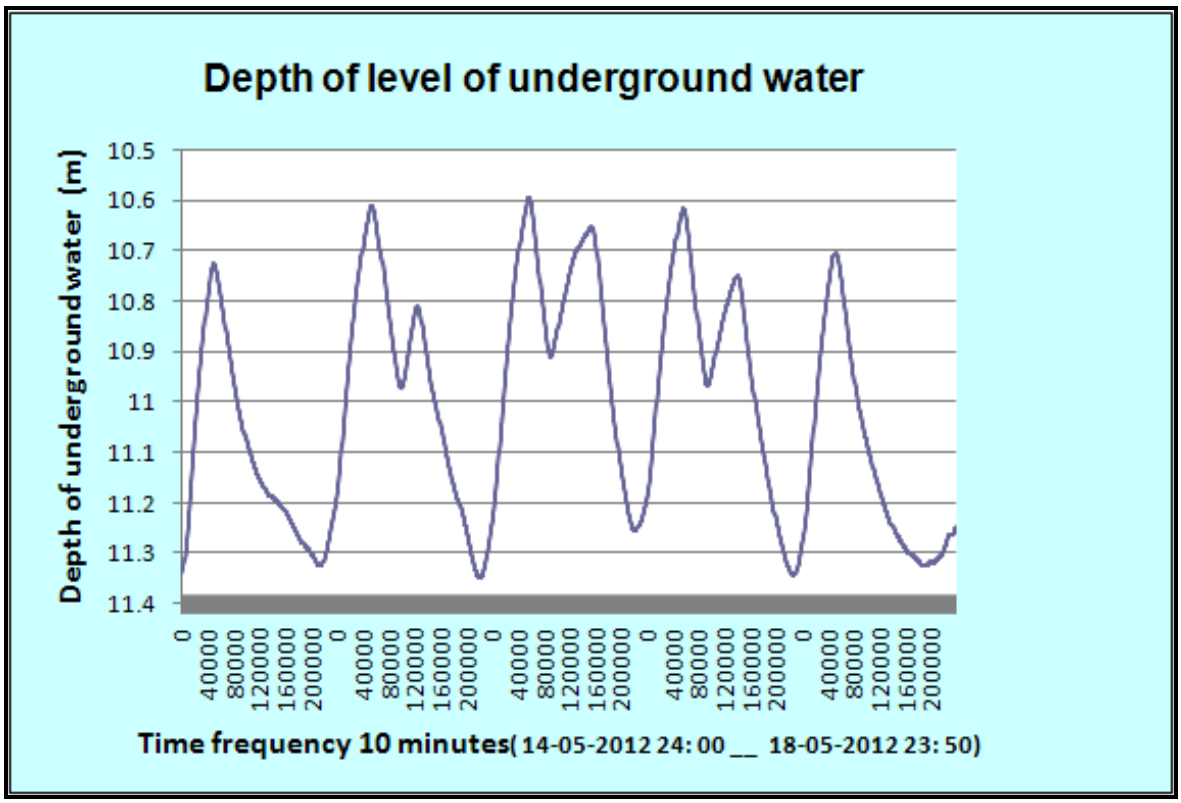
Depth of level of underground water
Depth of undergroundwater (m)
10.5
10.6
10.7
10.8
10.9
11
11.1
11.2
11.3
11.4
0
40000
80000
120000
160000
200000
Time frequency 10 minutes(14-05-2012 24: 00 __ 18-05-2012 23: 50)

Fig. 7

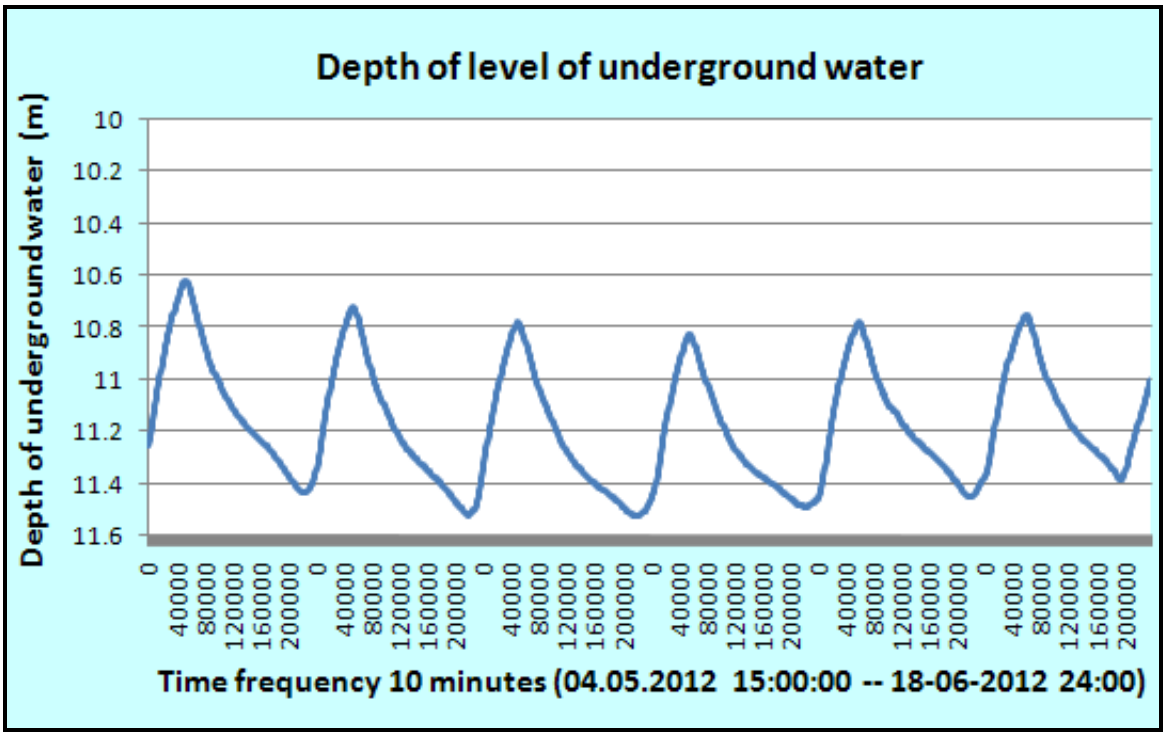
Depth of level of underground water
Depth of undergroundwater (m)
10
10.2
10.4
10.6
10.8
11
11.2
11.4
11.6
0
40000
80000
120000
160000
200000
Time frequency 10 minutes (04.05.2012 15:00:00 -- 18-06-2012 24:00)

Fig. 8

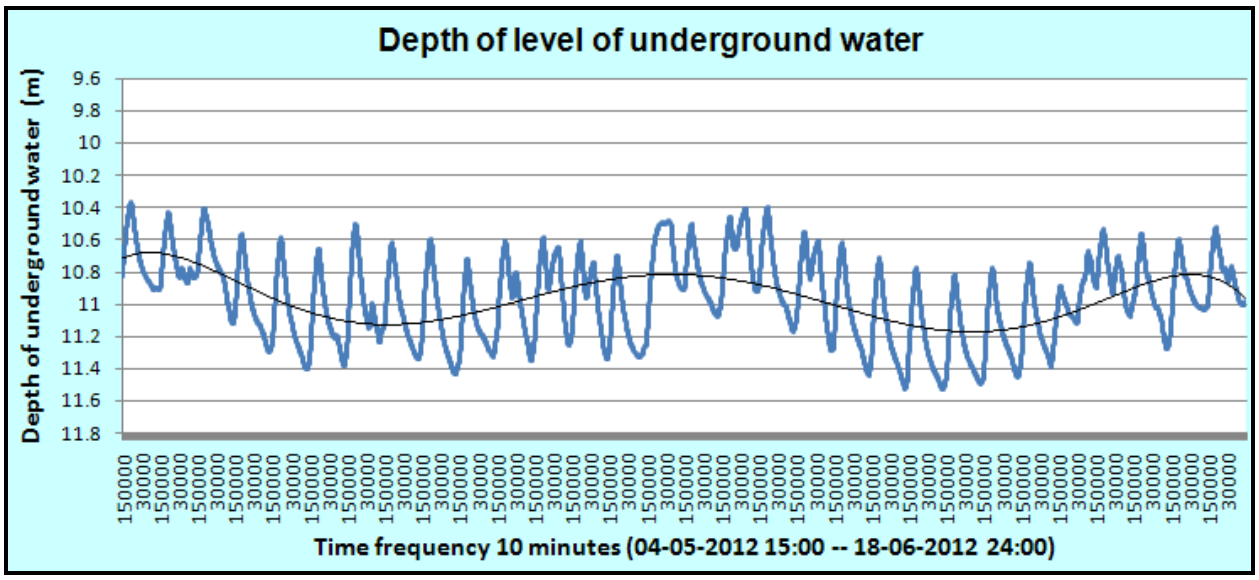

Fig. 9

Longer periods of tidal fluctuation of a level in a well 1301-4 are shown in figure 9, they have duration about 14-15 days and correspond to half of sidereal lunar month having duration 29,52 days. The maxima and minima of a level of these fluctuations correspond to highest syzygial tides and lowest quadrature tides, which depend on a joint position of the Moon and the Sun. Amplitude of a level of underground waters of these fluctuations is about 0,4 m. These fluctuations of a level were much more displayed in May - June 2012.

As it is known [1,2], at the expense of changes in declinations of the Moon and the Sun, in summer a day tide is above, than at night, and in winter, when declination of the Sun is southern - vice versa. Moreover, change of distance from the Moon up to the Earth within one month and the distances from the Earth up to the Sun within one year form change of sizes of forces, which make tide and create special long period anomalies in a course of tide. These anomalies are called parallactic inequalities. Thus, owing to daily rotation of the Earth and movement of the Earth, the Moon and the Sun on the orbits, the force of tide in each point on a surface of the Earth continuously varies in time, never precisely repeating. These features presence in the results of measurements , submitted in this article and they have to be taken into account at the analysis of change of a level of underground waters under the influence of tide.

In summary it is necessary to note, that measurement of fluctuations of a level of underground waters was performed from May 2012 till May 2013 with frequency 10 minutes, with the resolution 0,001м in a range of sizes ± 32,750 м and with accuracy ± 0,05 % of full scale, has shown the absence of any low-amplitude high-frequency regular fluctuations of a level, besides tidal, that, accordingly, absence of necessity of measurements with high temporary frequency, what is shown in figure 10. For this reason in the subsequent measurements the interval of measurements was increased till one hour.

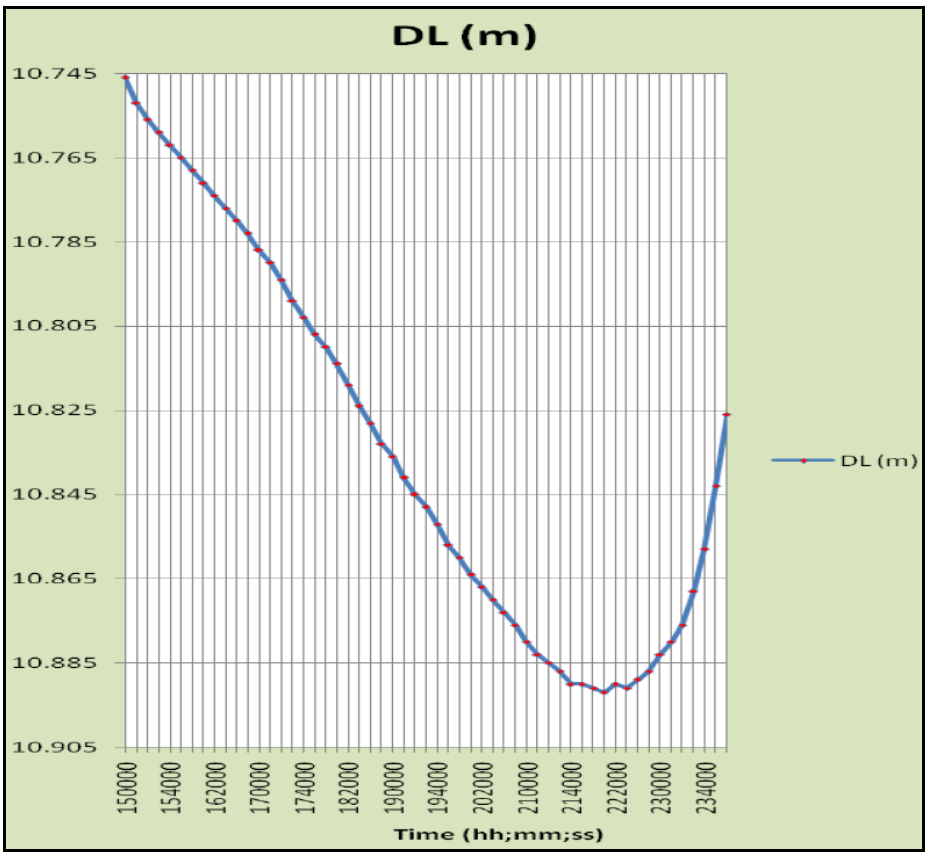

Fig. 10

The conclusion

The received data of observations for mode of level of underground waters on a well 1301-4 have allowed to reveal features of fluctuation of a level of underground waters caused of tides in terrestrial crust in limits of Chu basin, shown in daily one and two - period fluctuations of a level. These fluctuations of a level should be taken into account at measurement of levels during regime observations, They must be performed in the same time of a day or it is necessary to enter the appropriate correction. Besides, the executed observations have allowed to specify character of seasonal changes in 2012-2013 similar observed in previous years and relative stability of the size of static stocks of underground waters in limits of a researched site of Quaternary water-bearing complex of Chu basin of underground waters, used, in particular, for drinking water supply of Bishkek. The experience of using the automatic gauge for monitoring a level of underground waters and transfering of the information through the cellular communication on the Internet are important for the subsequent creation of an automatic network of observations of underground waters. The features in work of the gauge were being fixed during observations in winter period are important for improvement of results of observations at the expense of change of design or conditions of accommodation of the gauge in the future.

References

1. Melchior P. The Earth Tides // M.: MIR. 1968. 482 p.

2. Muslimov R.H., Mirzoev K.M., Ahmadiev R.G. and others.

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